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MATHEMATICS CURRICULA REQUIREMENTS AND PERFORMANCE LEVELS IN NAVY CLASS "C" ELECTRONICS SCHOOLS

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NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
San Diego, California 92152

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MATHEMATICS CURRICULA REQUIREMENTS AND PERFORMANCE LEVELS IN NAVY CLASS "C" ELECTRONICS SCHOOLS

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Instructors of 41 Navy electronics "C" courses were presented with a list of 70 mathematics skills and asked to indicate (1) how important they were to successful course performance and (2) whether required skills were prerequisite to, reviewed in, or taught in the course. Based on results obtained, a mathematical skills test was developed for the "C" course for the Aviation Electrician's Mate and Avionic Technician (AE/AV) ratings, and administered to entering and graduating students. Significant differences were found between the two groups on total test and in seven topic areas, most of which were taught

during the course. Since student performance in both groups was only marginal in most topic areas considered critical for successful course performance, it is possible that either the importance of these skills is overrated or criteria for successful course completion are too low.

FOREWORD

This research and development was conducted under exploratory development task area ZF63.522.011 (Assessment and Enhancement of Prerequisite Skills), work unit 522.011.03.02 (Enhancement and Computational Capabilities), and was sponsored by the Chief of Naval Operations (OP-01). The objectives of this work unit are to identify mathematics skill deficiencies among Navy electronics personnel, to determine the causes of such deficiencies, and to develop instruction strategies to improve the efficiency and job relevance of Navy electronics training.

This is the fourth in a series of reports designed to identify mathematical requirements relevant to electronics training. Previous reports issued described the mathematics skills identified as required for success in Navy electronics "A" schools, the differences in mathematical skill levels of entering and graduating "A" school students, and the mathematics skills identified as required for success in the Navy's Basic Electricity and Electronics schools (NPRDC TRs 81-4, 81-2, and 81-3). The purpose of the current effort was to identify the mathematics skills required for success at the Navy electronics "C" schools and to assess the performance of "C" school students in these skills. Results are intended for use by the Chief of Naval Education and Training and the Chief of Naval Technical Training.

Appreciation is expressed to the Navy "C" school instructors who participated in this study.

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SUMMARY

Problem and Background

The sophistication of military equipment is increasing while training budgets are decreasing. To assure cost-effective training, it is necessary to identify skills and knowledge essential for successful job performance in the fleet and the subordinate skills and knowledge the trainee must have to master these essential skills. Conversely, skills and knowledge not required for successful performance must be identified and considered for deletion from course objectives. To address this problem, the Center is conducting a project designed to identify mathematical requirements relevant to electronics training. Previous reports issued concerning this project described the mathematics skills identified as required to perform successfully in Navy electronics "A" schools, the differences in mathematics skills of entering and graduating "A" school students, and the skills identified as required to perform successfully in the Navy's Basic Electricity and Electronics (BE/E) schools.

Objective

The objectives of this effort were to identify those mathematics skills required for success in the Navy electronics "C" schools and, based on results, to assess the performance levels of "C" school students in these skill areas.

Approach

Instructors of 41 electronics "C" courses were asked to assess the importance of 70 mathematics skills for successful electronics course performance; to indicate whether the required skills are prerequisite, reviewed, or taught by the "C" schools; to state the number and type of performance aids used in each school; and to indicate how much time they spent reviewing and teaching skills rated as affecting performance. Since instructors of the "C" course for the Avionics Electrician's Mate (AE) and Avionic Technician (AV) ratings rated 65 of the surveyed skills as affecting performance, a mathematics test was developed for that course. This test was administered to 90 AE/AV students (40 entering and 50 graduating). Responses were compared to determine differences between the two groups.

Findings

1. The number of mathematics skills rated as affecting performance in the electronics Class "C" schools surveyed ranged from two (GM 5"54 MK-45, 5"54 MK-42, and GMLS MK-11 schools) to 65 (AE/AV common core).

2. Most of the teaching of mathematics occurs in the electrician schools (AE/AV, CE, and EM).

3. Most mathematics skills required by "C" courses for the electronics ratings (DS, EW, ET, and FT) are considered to be prerequisite.

4. Total time spent reviewing or teaching skills rated as affecting performance ranged from 0 to 26 percent of total training time.

5. Performance aids are permitted during "C" school courses and examinations. The nonprogrammable calculator is the most common performance aid.

6. Mean percent correct on a sample of mathematics items considered essential for successful AE/AV "C" school performance was 47 for entering students and 69 for graduating students.

7. Significant differences in mathematic test scores were found between entering students and graduating students on total test and in seven topic areas (Arithmetic Operations with Numbers, Units and Conversions, Decibels, Logarithms, Phasors, Number Bases, and Boolean Algebra).

Conclusions

Since student performance at the AE/AV "C" school in most topic areas considered in the curriculum as critical for successful course performance was only marginal, it is possible that the importance of these skills was overrated or that criteria for successful course completion are too low.

Recommendations

1. Further studies should be conducted to determine if the mathematics skills required by Navy "C" schools are justified to meet performance criteria in the schools or to satisfactorily perform electronics duties in the fleet.

2. The mathematics skill levels of students at preceding "A" schools should be examined so that Navy electronics training courses can be more closely coordinated to ensure consistency among prerequisites and subjects reviewed or taught. Also, the amount of time between graduation from "A" school and entry into "C" school, which in some ratings could be years, should be considered in determining the amount of review required.

The studies recommended above are currently being conducted by NAVPERSRAND-CEN.

CONTENTS

	Page
INTRODUCTION	1
Problem	1
Background	1
Purposes	2
APPROACH	5
Identification of Skills Necessary for Successful "C" School Performance	5
"C" School Students' Performance on Required Mathematics Skills	5
Test Development	5
Test Administration	7
RESULTS AND DISCUSSION	7
Identification of Class "C" School Mathematics Skill Requirements	7
Importance and Acquisition-level Ratings	7
Time Spent Reviewing and Teaching Mathematics Topics	8
Performance Aids Used	8
"C" School Students' Performance in Required Mathematics Skills	9
CONCLUSIONS	15
RECOMMENDATIONS	15
REFERENCES	17
APPENDIX--IMPORTANCE AND SKILL-ACQUISITION LEVEL RATINGS AND REVIEW AND TEACHING HOURS	A-0
DISTRIBUTION LIST	

LIST OF TABLES

		Page
1.	Class "C" Courses Surveyed	6
2.	Number of Items by Topic Area	7
3.	Skills Rated as Affecting Performance in "C" Courses	10
4.	Percent of Total Training Time Devoted to the Review and Teaching of Mathematics	14
5.	Mean Percent Correct, by Topic, for Entering and Graduating Groups	15

INTRODUCTION

Problem

The sophistication of military equipment is increasing while training budgets are decreasing. Thus, to assure cost-effective training, those skills and knowledges that are essential for successful job performance in the fleet must be identified, as well as the subordinate skills and knowledges that enable the trainee to master essential skills. Conversely, those skills and knowledges not required for successful performance must be identified and considered for deletion from course objectives.

Background

Navy recruits are assigned to ratings and corresponding Class "A" schools based on scores obtained on the Armed Services Vocational Aptitude Battery (ASVAB) that measures aptitudes in a number of areas. Over 23,000 of the approximately 60,000 recruits who enter Navy Class "A" schools every year are trained in electronics maintenance. Before these recruits enter "A" school, however, they must complete training on the fundamentals of electronic theory at one of the Basic Electricity and Electronics (BE/E) preparatory schools at Orlando, Florida; Memphis, Tennessee; Great Lakes, Illinois, and San Diego, California. After completing the BE/E and follow-on Class "A" school courses, most students are sent to the fleet. Some then return for more specialized training in electronics equipment at Class "C" schools. A small number of "C" school students come directly from the Class "A" schools. Figure 1 illustrates the electronics training sequence for the ratings of concern in this effort.

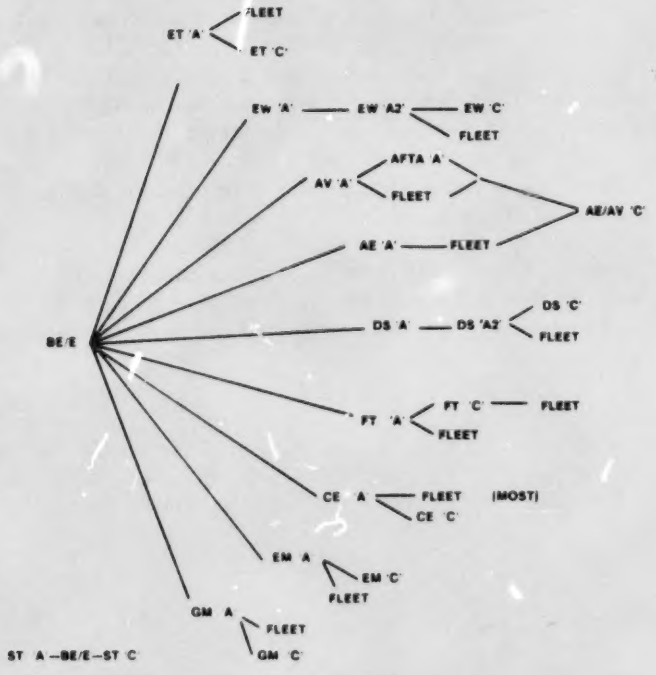

Figure 1. Electronics training sequence.

Although preliminary instruction for the electronics "C" school is more advanced than most Navy technical training, "C" school instructors frequently report that many students are not prepared to begin "C" school curricula. They cite mathematics skills as a primary deficiency among students and view this inadequacy as significantly contributing to unsatisfactory performance in electronics.

To address this problem, the Navy Personnel Research and Development Center is conducting a project designed to identify mathematical requirements relevant to electronics training. The purpose of the first task conducted under this project was to identify the mathematical skills necessary for successful performance in the Navy's electronics "A" schools (Sachar & Baker, 1981). After a review of several electronics mathematics textbooks, including the principal one used by Navy electronics schools, Basic Mathematics for Electronics (Cooke & Adams, 1970), 70 candidate skills were identified and grouped into 14 topic areas. Next, a survey form was developed that included two example problems for each of the 70 skills identified. These problems represented the range of difficulties found in the review of electronics mathematics materials. The skills included in the survey are listed on pages 3 and 4. A copy of the survey form was provided as an appendix to Sachar and Baker.

This survey was administered to instructors in 14 electronics "A" schools (12 basic and 2 advanced). For each skill, respondents were asked to indicate the level of importance of the skill to the course. Responses were to be made on a 6-point scale with 5 indicating "indispensable" and 0, "not required." For skills rated as affecting performance (i.e., above 1), respondents were asked to indicate the level of instruction provided on a 3-point scale, with P indicating "prerequisite" (must possess skill on entrance to course), R indicating "reviewed" (some level of skill is assumed, but skill is reviewed in course), and T indicating "taught" (no previous knowledge assumed, taught explicitly as a skill for the course). For curriculum design and development, it is necessary to know if required skills are taught in the training courses or are learned by the student before he entered the Navy. Finally, for skills indicated as being reviewed or taught, respondents were asked to state the amount of time spent reviewing or teaching the skills and whether any items relevant to the skills appeared on course tests. Based on survey results, Berger, Marr, Cremer, and Berger (1981) developed tests to assess the performance of entering and graduating "A" school students on those skills rated as affecting performance. These tests were administered to entering and graduating students of 10 "A" schools included in the previous study.

The third report (Baker, 1981) was conducted to identify those mathematics skills that are required to perform successfully at the Navy's BE/E schools, and, based on results, to assess BE/E school student performance levels in these required skills.

Purposes

The purposes of this study were to identify those mathematics skills that are required for success in Navy electronics Class "C" courses, and, based on results, to assess Class "C" student performance levels in required mathematics skills.

SKILLS INCLUDED IN THE MATHEMATICS SURVEY INSTRUMENT

Arithmetic Operations with Numbers (4):

1. Addition, subtraction, multiplication, and division of numbers
2. Squares and square roots of positive numbers
3. Powers and roots of positive numbers greater than squares and square roots
4. Percentage of numbers

Estimation (1):

5. Estimation of answers to arithmetic computation

Fractions (5):

6. Addition and subtraction of fractions
7. Multiplication and division of fractions
8. Powers and roots of fractions
9. Reduction of numeral fractions to lowest terms
10. Simplification of complex fractions

Units and Conversions (7):

11. Addition and subtaction of like units
12. Multiplication and division of like units
13. Multiplication and division of unlike units
14. Squares and square roots of units
15. Unit conversion between nonmetric and metric systems
16. Unit conversion within a metric system
17. Unit conversion within a nonmetric system

Scientific Notation (4):

18. Representation of numbers in scientific notation
19. Addition and subtraction of numbers in scientific notation
20. Multiplication and division of numbers in scientific notation
21. Powers and roots of numbers in scientific notation

Decibels (1):

22. Decibels

Logarithms (4):

23. Logs and antilogs found from log tables
24. Arithmetic computation using logs
25. Solution of logarithmic and exponential equations
26. Logs of numbers to bases other than 10, using base 10 log tables

Equations (6):

27. Substitution of known values into a given formula
28. Transpositions of algebraic expressions
29. Application of transpositions on equations with more than one variable
30. Solutions of quadratic equations
31. Soltuions of second-order simultaneous equations
32. Soltuions of third-order simultaneous equations

Algebraic Expressions (9):

33. Addition and subtraction of algebraic expressions
34. Multiplication and division of simple algebraic expressions
35. Multiplication of algebraic expressions up to binomials
36. Multiplication of algebraic expressions larger than binomials
37. Division of algebraic expressions
38. Powers and roots of simple algebraic expressions
39. Powers and roots of polynomials
40. Addition and subtraction of fractional algebraic expressions
41. Factoring algebraic expressions

Determinants (2):

42. Evaluation of determinants
43. Solutions of simultaneous equations using determinants

Geometry and Trigonometry (8):

44. Conversion of radian and degree measures of angles
45. Pythagorean theorem
46. Use of trigonometric tables to find specified function of a given angle or the angle of a given function
47. Solutions to right triangles
48. Calculations of the area of a given triangle
49. Solutions for unknown parts of a nonright triangle using laws of sines or cosines
50. Solutions of amplitude, frequency, phase angle, period, and angular velocity of a given periodic function
51. Amplification of sum and difference identities

Phasors (7):

52. Conversion of polar and rectangular coordinates
53. Powers and roots of signed numbers
54. Addition and subtraction of phasors in rectangular form
55. Addition and subtraction of polar phasors
56. Multiplication and division of phasors in rectangular form
57. Multiplication and division of polar phasors
58. Powers and roots of polar phasors

Number Bases (4):

59. Conversion of numbers to different number systems
60. Addition and subtraction in number systems from #59
61. Multiplication and division in number systems from #59
62. Complements of binary numbers

Boolean Algebra (8):

63. Conversion of Boolean expressions to truth tables
64. Conversion of logic diagrams to truth tables
65. Conversions of Boolean expressions to logic diagrams
66. Simplification of Boolean expressions
67. Conversion of logic diagrams to Boolean expressions
68. Simplification of Boolean expressions involving minterms (Veitch diagrams)
69. Conversion of truth tables to Boolean expressions
70. Conversion of truth tables to logic diagrams

APPROACH

Identification of Skills Necessary for Successful "C" School Performance

The survey developed by Sachar and Baker was administered to senior instructors of the 41 "C" courses listed in Table 1. These courses represented the 10 ratings surveyed by Sachar and Baker. In most cases, a sample of only four or five courses per rating were surveyed in ratings having six or more "C" courses. In all cases, "C" courses selected for the survey represented those having the highest student throughput.

The survey was administered in three increments--to AE/AV, CEG, EM, ET, FT, and GM instructors in January 1980, to CEP, DS, and EW instructors in March 1980, and to ST instructors in December 1980. It was stressed that responses should apply to the entire course as presently taught, not to the instructor's opinion on how the course should be taught. At the end of the survey, skills that elicited different responses were discussed and conflicts resolved. The entire session required approximately 1 hour.

After the discussion session, the instructors were asked to list the kind of mathematics performance aids (e.g., calculators, formula sheets, slide rules), if any, students use during the course and during examinations.

"C" School Students' Performance on Required Mathematics Skills

Test Development

Time and budget constraints limited testing to one Class "C" school. Therefore, it was decided to develop a test for the AE/AV school (common core) because instructors there had indicated that 65 of the mathematics skills surveyed affected course performance (see p. 8). AE/AV test items were selected, for the most part, from those developed by Berger et al. All items required a constructed response.

The primary considerations in constructing the test were ensuring that (1) the test reflected the instructor ratings of mathematics skills, (2) items represented reliable measures of mathematics skills, and (3) the number of items selected were appropriate for a 2-hour test. The third consideration limited the test to a sample of the skills indicated by AE/AV school instructors as being required for successful performance. Two required topic areas--Determinants, and Geometry/Trigonometry--were not included in the test. However, as topic/skill areas representative of the full range of importance and skill acquisition levels of the AE/AV "C" school were included, data obtained from the assessment should satisfy the objectives of the study. The number of items selected for each topic area are shown in Table 2.[1]

[1]A copy of the final test is available upon request from NAVPERSRANDCEN, Code 15.

Table 1

Class "C" Courses Surveyed

Rating	Location	Number of "C" Courses	"C" Courses Surveyed N	"C" Courses Surveyed Subject Covered
Aviation Electrician's Mate and Avionic Technician (AE/AV)[a]	Memphis	1 Common Core 3 Follow-on	1	Common Core
Construction Electrician (CE)[b]	Gulfport and Port Hueneme	2	2	Common Core
Data Systems Technician (DS)	Mare Island	16	14[c]	AN/UYK-7 CP-642A/B Data Transmissions VYA-4/SYA-4 Periph. (10)
Electrician's Mate (EM)	Great Lakes	1	1	Common Core
Electronics Technician (ET)	Great Lakes	6	6[d]	Common Core
Electronics Warfare Technician (EW)	Pensacola	8	4	AN/ULQ6C AN/WLR11A (BAND 10) AN/WLR-1C AN/SLQ-26
Fire Control Technician (FT)	Great Lakes	49	4	AN/UYK-7 MK-47 MK-86 AN/SPG-53F
Gunner's Mate (GM)	Great Lakes	6	5	5"54 MK-45 MK-10-C-30 18 5"54 MK-42 GMLS MK-11 MK-16 ASROC
Sonar Technician (ST)	San Diego	40	4	MK-114 AN/SQS-53 MK-111 AN/SQS-26CX
Total		132	41	

[a] Survey data were collected only on the combined AE/AV common-core course and not the follow-on individual "finger" courses.

[b] Two locations of the CE school were surveyed and treated independently to determine whether instructor responses were consistent aross locales.

[c] Survey responses related to mathematics required for all ten Peripheral "C" schools were combined.

[d] Survey responses related to mathematics requirements for all six ET "C" schools were combined.

Table 2

Number of Items by Topic Area

Topic	Number of Items
Arithmetic Operations with Numbers	8
Fractions	7
Units and Conversions	11
Scientific Notation	12
Decibels	3
Logarithms	7
Equations	10
Algebraic Expressions	4
Phasors	2
Number Bases	8
Boolean Algebra	16
Total	88

Test Administration

The test was administered to 90 students entering or graduating from the 18-week AE/AV "C" course at Memphis. The entering group, 40 students in WAITS status, were tested during January 1980. The graduating group, 50 students completing the last week of the course, were tested during May 1980.

Test administration procedures were identical for both groups. Students were tested in a group session and were allowed 2 hours to complete the test. All students had calculators and were permitted to use them.

RESULTS AND DISCUSSION

Identification of Class "C" School Mathematics Skill Requirements

Importance and Acquisition-level Ratings

Table 3,[2] which indicate the number of skills rated as affecting performance in the 41 "C" courses surveyed, shows that the number ranged from two for the GM 5"54 MK-45, 5"54 MK-42, and GMLS MK-11 courses to 65 for the AE/AV course. A more detailed breakdown of survey results is provided in the appendix.

Sets of mathematics skills are not common across courses. In fact, no one skill was rated as affecting every course. Even within ratings, most mathematics skills requirements among courses differ substantially. For example, instructors of the ST MK-114

[2]Because of the large number of tables in this section relative to the amount of text, the tables appear at the end of the section, beginning on page 10.

course indicated that Scientific Notation skills (Nos. 18 to 21) were not required, but instructors of the ST MK-111 school rated three of these skills as being essential for successful performance. Similarly, for the FT rating, instructors of the FT MK-47 course indicated that Boolean Algebra skills (Nos. 63 to 70) were not required, but instructors at the FT MK-86 course rated all Boolean Algebra skills as critical for successful course performance. Only the GM courses are similar as to mathematics requirements--because almost none is required.

Table 3 also indicates whether the required skills are prerequisite, reviewed, or taught in the "C" courses surveyed. As shown, except for the ST MK-111 course, most of the teaching of mathematics skills occurs in the electrician courses (AE/AV, CE, and EM). Apparently, required mathematics skills must be taught, rather than reviewed or considered prerequisite, in these schools because there was no requirement for these mathematics skills in the preceding "A" schools (Sachar & Baker, 1981). The mathematics requirements for the GM "C" courses, however, are no greater than those for the GM "A" schools.

In the electronics courses (DS, ET, EW, and FT), most mathematics skills rated as affecting performance are considered prerequisite. This is consistent with the amount of mathematics taught in the "A" schools associated with these ratings.

As with importance ratings, acquisition levels of sets of mathematics skills among courses, both within and between ratings, follow no consistent pattern. Even within a rating, where skill importance within a topic area was similar across schools, the skill-acquisition levels were often very different, as demonstrated by the FT AN/UYK-7 and MK-86 courses. Although instructors of both courses rated Boolean Algebra as critical for successful course performance, the AN/UYK-7 course reviews such skills and the MK-86 course requires them as prerequisite. Students at both schools received the same prerequisite training at the FT "A" school, where skills 66 and 68 (Boolean Algebra) are not taught (Sachar & Baker, 1981). Thus, there is no place in the current training sequence where the student would have been taught these skills (and it is unlikely the skills would have been acquired before students joined the Navy). Conversely, Boolean Algebra is taught at the ST "A" school and taught again at three of the four ST "C" courses.

Time Spent Reviewing and Teaching Mathematics Topics

As shown in Table 4, the time spent reviewing mathematics skills rated by instructors as affecting performance ranged from 0 to 190 hours, and the total time spent teaching them ranged from 0 to 66 hours. Thirty-eight (93%) of the 41 "C" courses surveyed spent less than 10 percent of their total training time reviewing and teaching mathematics skills; and 27 (66%), less than 5 percent. These low percentages of mathematics training time, even in courses where a large number of mathematics skills are required, indicate that students entering "C" courses are expected to have some sophistication in mathematics.

Performance Aids Used

The instructors indicated that performance aids, which reduce the need for some mathematics skills, may be used during "C" school courses and examinations. Calculators speed mathematics operations and eliminate the need for skills such as those involving fractions. The low cost of simple calculators, within the budget of recruits, has made them the most commmon arithmetic aid. Because of their widespread use in all "C" schools, students perform few mathematics operations manually.

"C" School Students' Performance in Required Mathematics Skills

Results of the test administered to AE/AV entering and graduating skills was analyzed to provide split-half reliability coefficients with Spearman-Brown correction applied. Reliability coefficients for the total test were .857 for the entering group and .913 for the graduating group.

Since the same test was given to both the entering and graduating students, direct comparisons could be made. For the entering group, the percent correct on the total test ranged from 13 to 69, with a mean of 41.77 and a standard deviation of 14.03. For graduating students, the percent correct ranged from 36 to 86, with a mean of 60.48 and a standard deviation of 12.52. Table 5 presents the mean percent correct by topic for each of the groups.

The t-test for independent groups was applied to the differences between the mean scores of entering and graduating students on the total test and topic areas. As shown in Table 5, the two groups differed significantly on total test and on seven topic areas. The results for the Decibels, Logarithms, Phasors, Number Bases, and Boolean Algebra areas are not surprising, since instructors indicated that most skills within these areas were taught during the course (see appendix). They were not taught at either the AE or AV "A" schools or the BE/E school, prerequisites to the AE/AV "C" course (Sachar & Baker, 1981; Baker, 1981).

Required skills in the Equations and Scientific Notation areas were either taught or reviewed during the course; those in Fractions were reviewed. However, the mean scores of entering and graduating students did not differ significantly in these topic areas. Since these subjects were either prerequisite to the BE/E school or were taught there (Baker, 1981), their review in the AE/AV "C" school may have been limited. However, Arithmetic Operations and Units and Conversions skills were also prerequisite to or taught at the BE/E school and significant differences did occur between mean scores of the two groups. This may have occurred because the skills were exercised as components of other mathematics skills essential to the course.

No significant differences were found between the mean scores of entering and graduating student on Algebraic Expression skills. Since these skills are reviewed, not taught, in the AE/AV "C" course, significant differences in the scores of entering and graduating students were not expected. It is noteworthy, however, that, although Algebraic Expressions was not taught in BE/E or AV/AE "A" schools, entering students did as well in this topic as they did in Units and Conversions and Equations, which were taught, reviewed, or considered prerequisites for BE/E and AE/AV "A" schools. It must be assumed that students learned Algebraic Expressions skills before entering the Navy. The high scores for the entering group indicate extremely good retention of these skills.

Table 3

Skills Rated as Affecting Performance in "C" Courses

Rating	Course	Skills Rated as Affecting Performance: Topic Area	Skill No.	Total Number of Skills Required	Level of Acquisition: Pre-requisite N	Pre-requisite %	Reviewed N	Reviewed %	Taught N	Taught %
AE/AV	Common Core	Arithmetic Operations	1-4	4						
		Fractions	6-10	5						
		Units and Conversions	11-16	6						
		Scientific Notation	8-21	4						
		Decibels	22	1						
		Logarithms	23-26	4						
		Equations	27-32	6						
		Algebraic Expressions	33-41	9						
		Determinants	42-43	2						
		Geometry and Trigonometry	44-45, 47, 49-51	6						
		Phasors	52-57	6						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				65	1	1	30	47	34	52
CEG	Common Core	Arithmetic Operations	1-4	4						
		Fractions	6-10	5						
		Units and Conversions	11-12, 16	3						
		Scientific Notation	18-20	3						
		Equations	27-29	3						
		Geometry and Trigonometry	44-47, 49	5						
		Phasors	52-57	6						
				29	1	3	6	21	22	76
CEP	Common Core	Arithmetic Operations	1-4	4						
		Estimations	5	1						
		Fractions	6-7, 9-10	4						
		Units and Conversions	11-17	7						
		Scientific Notation	20	1						
		Equations	27-29	3						
		Algebraic Expressions	33	1						
		Geometry and Trigonometry	45-47	3						
				24	3	13	8	33	13	54
DS	AN/UYK-7	Arithmetic Operations	1-2	2						
		Scientific Notation	17-20	3						
		Number Bases	59-62	4						
		Boolean Algebra	63-64	2						
				11	0	0	11	100	0	0
	CP-642A/B	Arithmetic Operations	1-2	2						
		Scientific Notation	18-21	4						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				18	13	72	1	6	4	22
	Data Transmissions	Arithmetic Operations	1-2, 4	3						
		Estimations	5	1						
		Fractions	6-7, 9	3						
		Units and Conversions	11-12, 14, 16	4						
		Scientific Notation	18-20	3						
		Decibels	22	1						
		Equations	27-28	2						
		Geometry and Trigonometry	45-47	3						
		Number Bases	59-60, 62	3						
		Boolean Algebra	63-67, 69-70	7						
				30	25	83	2	7	3	10
	VYA-4/SYA-4	Arithmetic Operations	1-4	4						
		Fractions	6-10	5						
		Units and Conversions	11-17	7						
		Scientific Notation	18-21	4						
		Equations	27-32	6						
		Algebraic Expressions	33-41	9						
		Geometry and Trigonometry	51	1						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				48	47	98	1	2	0	0

Table 3 (Continued)

Rating	Course	Skills Rated as Affecting Performance: Topic Area	Skill No.	Total Number of Skills Required	Level of Acquisition: Pre-requisite N	Pre-requisite %	Reviewed N	Reviewed %	Taught N	Taught %
DS (Cont.)	Peripheral (10 schools)	Arithmetic Operations	1	1						
		Units and Conversions	11-12	2						
		Logarithms	23-25	3						
		Geometry and Trigonometry	44-47, 50-51	6						
		Number Bases	59-60	2						
		Boolean Algebra	63-64	2						
				16	14	88	1	6	1	6
EM	Common Core	Arithmetic Operations	1-4	4						
		Fractions	6-10	5						
		Units and Conversions	11-14, 16	5						
		Scientific Notation	18-20	3						
		Equations	27-29	3						
		Geometry and Trigonometry	45-47, 50	4						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				36	1	3	23	63	12	33
ET	Common Core (6 schools)	Arithmetic Operations	1-4	4						
		Estimations	5	1						
		Fractions	6-10	5						
		Units and Conversions	11-13, 15-17	5						
		Scientific Notation	18-20	3						
		Decibels	22	1						
		Number Bases	59-60, 62	3						
		Boolean Algebra	63-70	8						
				30	20	67	10	33	0	0
EW	AN/ULQ6C	Arithmetic Operations	1-4	4						
		Estimations	5	1						
				5	3	60	2	40	0	0
	AN/WLR11A (BAND 10)	Arithmetic Operations	1-2, 4	3						
		Estimations	5	1						
		Fractions	6-10	5						
		Units and Conversions	11-17	7						
		Scientific Notation	18-21	4						
		Decibels	22	1						
		Logarithms	23-26	4						
		Equations	27-32	6						
		Algebraic Expressions	33-41	9						
		Boolean Algebra	63-70	8						
				48	48	100	0	0	0	0
	AN/WLR-1C	Arithmetic Operations	1-4	4						
		Estimations	5	1						
		Fractions	6-10	5						
		Units and Conversions	11-14, 16	5						
		Scientific Notation	18-21	4						
		Decibels	22	1						
		Logarithms	23-26	4						
		Equations	27-32	6						
		Algebraic Expressions	33-35	3						
		Geometry and Trigonometry	44-51	8						
		Phasors	52	1						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				54	50	93	4	7	0	0
	AN/SLQ-26	Arithmetic Operations	1-4	4						
		Estimations	5	1						
				5	3	60	2	40	0	0
FT	AN/UYK-7	Arithmetic Operations	1-3	3						
		Units and Conversions	11-13	3						
		Scientific Notation	18	1						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				19	6	32	13	68	0	0

Table 3 (Continued)

Rating	Course	Skills Rated as Affecting Performance: Topic Area	Skill No.	Total Number of Skills Required	Level of Acquisition: Pre-requisite N	Pre-requisite %	Reviewed N	Reviewed %	Taught N	Taught %
FT (Cont.)	MK-47	Arithmetic Operations	1-4	4						
		Estimations	5	1						
		Fractions	6-10	5						
		Units and Conversions	11-17	7						
		Scientific Notation	18-21	4						
		Decibels	22	1						
		Equations	27-30	4						
		Algebraic Expressions	33	1						
		Geometry and Trigonometry	45-49	5						
				32	15	47	15	47	2	6
	MK-86	Arithmetic Operations	1, 4	2						
		Fractions	7-8	2						
		Units and Conversions	11-13, 16	4						
		Decibels	22	1						
		Logarithms	23-26	4						
		Equations	27-28	2						
		Geometry and Trigonometry	44, 46, 49, 51	4						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				31	18	58	8	26	5	16
	AN/SPG-53F	Arithmetic Operations	1-4	4						
		Estimations	5	1						
		Fractions	6-7	2						
		Units and Conversions	11-14, 16-17	6						
		Scientific Notation	18-20	3						
		Decibels	22	1						
		Equations	27-29	3						
		Geometry and Trigonometry	44-47, 48	5						
		Number Bases	59-60	2						
		Boolean Algebra	67, 70	2						
				29	28	97	1	3	0	0
GM	5"54 MK-45	Arithmeticc Operations	1	1						
		Units and Conversions	16	1						
				2	2	100	0	0	0	0
	MK-10-C-30 18	Arithmetic Operations	1	1						
		Fractions	6, 9	2						
		Units and Conversions	11-13, 16-17	5						
		Scientific Notation	18, 20	2						
		Equations	27-28	2						
		Geometry and Trigonometry	44	1						
				13	13	100	0	0	0	0
	5"54 MK-42	Arithmetic Operations	1, 4	2						
				2	2	100	0	0	0	0
	GMLS MK-11	Boolean Algebra	64, 70	2						
				2	2	100	0	0	0	0
	MK-16 ASROC	Arithmetic Operations	1, 4	2						
		Units and Conversions	12	1						
		Boolean Algebra	63-70	8						
				11	11	100	0	0	0	0
ST	MK-114	Arithmetic Operations	1	1						
		Units and Conversions	11, 13, 16-17	4						
		Equations	27-28	2						
		Algebraic Expressions	33	1						
		Geometry and Trigonometry	45-47, 51	4						
		Phasors	52	1						
		Number Bases	59	1						
		Boolean Algebra	63-64, 66-67	4						
				18	6	33	7	39	5	28

Table 3 (Continued)

Rating	Course	Skills Rated as Affecting Performance: Topic Area	Skill No.	Total Number of Skills Required	Level of Acquisition: Pre-requisite N	Pre-requisite %	Reviewed N	Reviewed %	Taught N	Taught %
ST (Cont.)	AN/SQS-53	Arithmetic Operations	1-2, 4	3						
		Estimations	5	1						
		Units and Conversions	11-13, 16-17	5						
		Scientific Notation	18	1						
		Decibels	22	1						
		Equations	27-29	3						
		Algebraic Expressions	33-34, 37, 40	4						
		Geometry and Trigonometry	45-47, 50-51	5						
		Phasors	52, 54-57	5						
		Number Bases	59-60, 62	3						
		Boolean Algebra	63-65, 67, 69-70	6						
				37	8	22	22	59	7	19
	MK-111	Arithmetic Operations	1-3	3						
		Units and Conversions	11, 13, 16	3						
		Scientific Notation	18-20	3						
		Geometry and Trigonometry	45-47	3						
		Number Bases	59-62	4						
		Boolean Algebra	63-70	8						
				24	1	4	9	38	14	58
	AN/SQS-26CX	Arithmetic Operations	1-4	4						
		Units and Conversions	11-12, 16-17	4						
		Scientific Notation	18	1						
		Equations	27	1						
		Algebraic Expressions	33-37	5						
		Geometry and Trigonometry	45-47	3						
		Number Bases	59-60, 62	3						
		Boolean Algebra	63-65, 67	4						
				25	8	32	14	56	3	12

Table 4

Percent of Total Training Time Devoted to the Review and Teaching of Mathematics

"C" Schools Surveyed	Course Length (Hours)	No. of Skills Rated Rated Above "1"	Hours Spent Reviewing & Teaching Mathematics R	T	Total	Percent of Total Training Time
AE/AV Common Core	540	65	17	43	60	11
CEG Common Core	330	29	5	37	42	13
CEP Common Core	360	24	10	22	32	9
DS						
AN/UYK-7	300	11	8.7	0	8.7	3
CP-642 A/B	450	18	1	4	5	1
Data Transmissions	390	30	2	2	4	1
VYA-4SYA-4	780	48	8	0	8	1
Peripheral (10 schools)	420[a]	16	3	4	7	2
EM Common Core	540	36	55	20	75	14
ET Common Core (6 schools)	270[b]	30	24	0	24	9
EW						
AN/ULQ-6C1	120	5	2	0	2	2
AN/WLR-11A (No longer taught)	—	48	0	0	0	0
AN/WLR-1C	330	54	0.5	3	3.5	1
AN/SLQ-26	300	5	2	0	2	1
FT						
AN/UYK-7	510	19	21	0	21	4
MK-47	450	32	9	2	11	2
MK-86	690	31	8	14	22	3
AN/SPG-53F	480	29	0	0	0	0
GM						
5"/54 MK-45	495	2	0	0	0	0
MK-10-C-30 18	600	13	0	0	0	0
5"54 MK-42	570	2	0	0	0	0
GMLS MK-11	690	2	0	0	0	0
MK-16 ASROC	315	11	0	0	0	0
ST						
MK-114	450	18	26	16	42	9
AN/SQS-53	990	37	190	66	256	26
MK-111	630	24	26	26	52	8
AN/SQS-26CX	900	25	72	5	77	9

[a]Mean course length for 10 peripheral schools.

[b]Mean course length for 6 ET schools.

Table 5

Mean Percent Correct, by Topic, for Entering and Graduating Groups

Topic	Number of Items	Entering Mean % Correct	Graduating Mean % Correct	t test
Total Test	88	42	60	6.67*
Arithmetic Operations	8	81	93	3.14*
Fractions	7	82	77	1.61
Units and Conversions	11	57	74	4.29*
Scientific Notation	12	58	67	1.45
Decibels	3	7	29	3.48*
Logarithms	7	23	57	6.33*
Equations	10	64	72	1.49
Algebraic Expressions	4	62	56	0.82
Phasors	2	3	50	5.95*
Number Bases	8	44	82	6.88*
Boolean Algebra	16	13	61	13.00*
Total	88	47	69	

*p < .001.

CONCLUSIONS

Though statistically significant differences were found between mean scores of entering and graduating groups for total test and for 7 of the 11 topic areas tested, the mean scores of both groups were quite low on skills rated as affecting performance. Since students in the graduating group all successfully completed the course, it appears that either these mathematics skills may not be as critical as instructors indicate or criteria for successful course completion are too low.

RECOMMENDATIONS

1. Further studies should be conducted to determine if the mathematics skills required by Navy "C" schools are really needed to meet performance criteria in the schools or to satisfactorily perform electronics duties in the fleet.

2. The mathematics skill levels of students at preceding "A" schools should be examined so that Navy electronics training courses can be more closely coordinated to ensure consistency among prerequisites and subjects reviewed or taught. Also, the amount of time between graduation from "A" school and entry into "C" school, which in some ratings could be years, should be considered in determining the amount of review required.

The studies recommended above are currently being conducted by NAVPERSRAND-CEN.

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APPENDIX

IMPORTANCE AND SKILL-ACQUISITION LEVEL RATINGS AND REVIEW AND TEACHING HOURS

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	AE/AV I	AE/AV L	AE/AV H	CE-G I	CE-G L	CE-G H	CE-P I	CE-P L	CE-P H	EM I	EM L	EM H	GM 5"54 MK-45 I	GM 5"54 MK-45 L	GM 5"54 MK-45 H	GM MK-10-C-30 18 I	GM MK-10-C-30 18 L	GM MK-10-C-30 18 H	GM 5"54 MK-42 I	GM 5"54 MK-42 L	GM 5"54 MK-42 H	GM GMLS MK-11 I	GM GMLS MK-11 L	GM GMLS MK-11 H	GM MK-16 ASROC I	GM MK-16 ASROC L	GM MK-16 ASROC H
Arithmetic Operations with Numbers (4)	1	5	R		5	R		5	P		4	P		5	P		3	P		3	P		0			2	P	
	2	5	R		5	T		5	T		5	R		0			0			0			0			0		
	3	5	R		5	T		3	T		4	R		0			0			0			0			0		
	4	3	P		4	R		5	P		4	R		0			0			3	P		0			2	P	
		(4)		4R	(4)		2R6T	(4)		1R1T	(4)		4R	(1)		0	(1)		0	(2)			(0)		0	(2)		0
Estimations (1)	5	0			0			4	R		0			0			0			0			0			0		
		(0)		0	(0)		0	(1)		4R	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0
Fractions (5)	6	5	R		4	R		4	T		4	R		0			2	P		0			0			0		
	7	5	R		3	R		4	R		4	R		0			0			0			0			0		
	8	5	R		4	T		1	P		4	R		0			0			0			0			0		
	9	5	R		3	R		4	R		4	R		0			2	P		0			0			0		
	10	5	R		3	R		3	R		4	R		0			1	P		0			0			0		
		(5)		4R	(5)		3R2T	(4)		2R1T	(5)		4R	(0)		0	(2)		0	(0)		0	(0)		0	(0)		0
Units & Conversions (7)	11	5	R		5	T		5	R		5	R		0			2	P		0			0			0		
	12	5	R		5	T		3	R		4	R		0			2	P		0			0			2	P	
	13	5	R		0			5	T		4	R		0			2	P		0			0			0		
	14	5	R		0			5	T		4	R		0			0			0			0			0		
	15	5	R		0			2	P		0			0			0			0			0			0		
	16	5	R		5	P		5	T		5	R		2	P		2	P		0			0			0		
	17	0			0			3	R		0			0			2	P		0			0			0		
		(6)		2R	(3)		2T	(7)		2R1T	(5)		6R	(1)		0	(5)		0	(0)		0	(0)		0	(1)		0
Scientific Notation (4)	18	5	T		5	T		0			4	R		0			3	P		0			0			0		
	19	4	R		5	T		0			4	R		0			1	P		0			0			0		
	20	4	R		5	T		2	R		4	R		0			3	P		0			0			0		
	21	4	R		0			0			1	R		0			0			0			0			0		
		(4)		2R	(3)		3T	(1)		1R2T	(3)		4R	(0)		0	(2)		0	(0)		0	(0)		0	(0)		0

1. Importance (I) ratings are based on responses made on a 6-point scale where 0=Not required, 1=Dispensable, 2=Somewhat useful, 4=Very important, and 5=Indispensable.
2. Skill acquisition level (L) ratings are based on a 3-point scale where P=Prerequisite, R=Reviewed, and T=Taught.
3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance).

A-1

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	AE/AV I	AE/AV L	AE/AV H	CE-G I	CE-G L	CE-G H	CE-P I	CE-P L	CE-P H	EM I	EM L	EM H	GM 5"54 MK-45 I	GM 5"54 MK-45 L	GM 5"54 MK-45 H	GM MK-10-C-30 18 I	GM MK-10-C-30 18 L	GM MK-10-C-30 18 H	GM 5"54 MK-42 I	GM 5"54 MK-42 L	GM 5"54 MK-42 H	GM GMLS MK-11 I	GM GMLS MK-11 L	GM GMLS MK-11 H	GM MK-16 ASROC I	GM MK-16 ASROC L	GM MK-16 ASROC H
Decibels (1)	22	3	T		0			0			0			0			0			0			0			0		
		(1)		1T	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0
Logarithms (4)	23	5	T		1	T		0			0			0			0			0			0			0		
	24	5	T		1	T		0			0			0			0			0			0			0		
	25	5	T		0			0			0			0			0			0			0			0		
	26	4	T		0			0			0			0			0			0			0			0		
		(4)		2T	(0)		4T	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0
Equations (6)	27	5	R		5	T		5	T		5	R		0			2	P		0			0			0		
	28	5	R		5	T		5	T		5	R		0			2	P		0			0			0		
	29	5	R		5	T		5	T		3	R		0			1	P		0			0			0		
	30	5	T		0			0			0			0			1	P		0			0			0		
	31	5	T		0			0			0			0			0			0			0			0		
	32	4	T		0			0			0			0			0			0			0			0		
		(6)		2.5R	(3)		8T	(3)		8T	(3)		2R	(0)		0	(2)		0	(0)		0	(0)		0	(0)		0
Algebraic Expressions (9)	33	5	R		0			5	T		0			0			0			0			0			0		
	34	5	R		0			0			0			0			C			0			0			0		
	35	5	R		0			0			0			0			0			0			0			0		
	36	5	R		0			0			0			0			0			0			0			0		
	37	5	R		0			0			0			0			0			0			0			0		
	38	5	R		0			0			0			0			0			0			0			0		
	39	5	R		0			0			0			0			0			0			0			0		
	40	5	R		0			0			0			0			0			0			0			0		
	41	5	R		0			0			0			0			0			0			0			0		
		(9)		2.5R	(0)		0	(1)		1T	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0
Determinants (2)	42	4	T		0			0			0			0			0			0			0			0		
	43	4	T		0			0			0			0			0			0			0			0		
		(2)		2T	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0

1. Importance (I) ratings are based on responses made on a 6-point scale where 0=Not required, 1=Dispensable, 2=Somewhat useful, 4=Very important, and 5=Indispensable.
2. Skill acquisition level (L) ratings are based on a 3-point scale where P=Prerequisite, R=Reviewed, and T=Taught.
3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance).

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	AE/AV I	AE/AV L	AE/AV H	CE-G I	CE-G L	CE-G H	CE-P I	CE-P L	CE-P H	EM I	EM L	EM H	GM 5"54 MK-45 I	GM 5"54 MK-45 L	GM 5"54 MK-45 H	GM MK-10-C-30 18 I	GM MK-10-C-30 18 L	GM MK-10-C-30 18 H	GM 5"54 MK-42 I	GM 5"54 MK-42 L	GM 5"54 MK-42 H	GM GMLS MK-11 I	GM GMLS MK-11 L	GM GMLS MK-11 H	GM MK-16 ASROC I	GM MK-16 ASROC L	GM MK-16 ASROC H
Geometry & Trig-onometry (8)	44	3	T		5	T		0			0			0			2	P		0			0			0		
	45	4	T		5	T		5	T		5	R		0			0			0			0			0		
	46	1	T		5	T		5	T		5	R		0			0			0			0			0		
	47	5	T		5	T		5	T		4	R		0			0			0			0			0		
	48	0			0			0			0			0			0			0			0			0		
	49	3	T		3	T		0			0			0			0			0			0			0		
	50	3	T		0			0			5	R		0			0			0			0			0		
	51	2	T		0			0			0			0			0			0			0			0		
		(6)		3T	(5)		8T	(3)		8T	(4)		5R	(0)		0	(1)		0	(0)		0	(0)		0	(0)		0
Phasors (7)	52	5	T		5	T		0			0			0			0			0			0			0		
	53	5	R		2	T		0			0			0			0			0			0			0		
	54	5	T		5	T		0			0			0			0			0			0			0		
	55	5	T		5	T		0			0			0			0			0			0			0		
	56	5	T		5	T		0			0			0			0			0			0			0		
	57	5	T		2	T		0			0			0			0			0			0			0		
	58	0			0			0			0			0			0			0			0			0		
		(6)		3T	(6)		4T	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0
Number Bases (4)	59	5	T		0			0			5	T		0			0			0			0			0		
	60	5	T		0			0			5	T		0			0			0			0			0		
	61	5	T		0			0			5	T		0			0			0			0			0		
	62	5	T		0			0			5	T		0			0			0			0			0		
		(4)		16T	(0)		0	(0)		0	(4)		15R10T	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0
Boolean Algebra (8)	63	5	T		0			0			5	T		0			0			0			0			2	P	
	64	5	T		0			0			5	T		0			0			0			5	P		2	P	
	65	5	T		0			0			5	T		0			0			0			0			2	P	
	66	5	T		0			0			5	T		0			0			0			0			2	P	
	67	5	T		0			0			5	T		0			0			0			0			2	P	
	68	5	T		0			0			5	T		0			0			0			0			2	P	
	69	5	T		0			0			5	T		0			0			0			0			2	P	
	70	5	T		0			0			5	T		0			0			0			5	P		2	P	
		(8)		16T	(0)		0	(0)		0	(8)		15R10T	(0)		0	(0)		0	(0)		0	(2)		0	(8)		0
TOTAL		65		17R43T	29		5R37T	24		10R22T	36		55R20T	2		0	13		0	2		0	2		0	11		0

1. Importance (I) ratings are based on responses made on a 6-point scale where 0=Not required, 1=Dispensable, 2=Somewhat useful, 4=Very important, and 5=Indispensable.

2. Skill acquisition level (L) ratings are based on a 3-point scale where P=Prerequisite, R=Reviewed, and T=Taught.

3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance)

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	DS AN/UYK-7 I	L	H	DS CP-642A/B I	L	H	DS Data Transmissions I	L	H	DS VYA-4/SYA-4 I	L	H	DS Periph. I	L	H	EW AN/UL[illegible] I	L	H	EW AN/WLR-11A(BAND 10) I	L	H	EW AN/WLR-1C I	L	H	EW AN/SLQ-26 I	L	H
Arithmetic Operations with Numbers (4)	1	2	R		5	P		4	P		5	P		2	P		5	P		5	P		5	P		5	P	
	2	2	R		5	R		3	P		5	P		1	P		5	R		5	P		5	P		5	R	
	3	1	P		0			0			5	P		0			5	P		0			5	P		5	P	
	4	0			0			3	P		4	P		0			5	R		4	P		5	P		5	R	
		(2)		5R	(2)		1R	(3)		0	(4)			(1)		0	(4)		2R	(3)		0	(4)		0	(4)		2R
Estimations (1)	5	0			0			2	P		0			0			5	P		5	P		4	P		5	P	
		(0)		0	(0)		0	(1)		0	(0)		0	(0)		0	(1)		0	(1)		0	(1)		0	(1)		0
Fractions (5)	6	1	P		0			2	P		5	P		1	P		0			2	P		5	P		0		
	7	0			0			3	P		5	P		0			0			2	P		5	P		0		
	8	0			0			0			5	P		0			0			2	P		5	P		0		
	9	0			0			2	P		5	P		0			0			2	P		5	P		0		
	10	0			0			0			5	P		0			0			2	P		5	P		0		
		(0)		0	(0)		0	(3)		0	(5)		0	(0)		0	(0)		0	(5)		0	(5)		0	(0)		0
Units & Conversions (7)	11	1	R		1	P		4	P		5	P		2	P		0			5	P		5	P		0		
	12	1	P		1	P		4	P		5	P		2	P		0			5	P		5	P		0		
	13	0			1	P		0			5	P		1	P		0			5	P		5	P		0		
	14	0			1	P		2	P		5	P		0			0			5	P		5	P		0		
	15	0			0			0			4	P		0			0			5	P		0			0		
	16	1	R		1	P		4	P		4	P		1	P		0			5	P		5	P		0		
	17	0			0			0			5	P		1	P		0			4	P		0			0		
		(0)		.25R	(0)		0	(4)		0	(7)		0	(2)		0	(0)		0	(7)		0	(5)		0	(0)		0
Scientific Notation (4)	18	3	R		5	T		4	P		5	P		0			0			5	P		5	P		0		
	19	2	R		5	T		2	P		5	P		0			0			5	P		5	P		0		
	20	2	R		5	T		2	P		5	P		0			0			5	P		5	P		0		
	21	0			5	T		0			5	P		0			0			5	P		5	P		0		
		(3)		1R	(4)		4T	(3)		0	(4)		0	(0)		0	(0)		0	(4)		0	(4)		0	(0)		

1. Importance (I) ratings are based on responses made on a 5-point scale where 0=Not required, 1=Dispensable, 2=Somewhat useful, 4=Very important, and 5=Indispensable.
2. Skill acquisition level (L) ratings are based on a 3-point scale where P=Prerequisite, R=Reviewed, and T=Taught.
3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance).

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	DS AN/UYK-7 I	L	H	DS CP-642A/B I	L	H	DS Data Transmissions I	L	H	DS VYA-4/SYA-4 I	L	H	DS Periph. I	L	H	EW AN/ULQ6C I	L	H	EW AN/WLR11A(BAND 10) I	L	H	EW AN/WLR-1C I	L	H	EW AN/SLQ-26 I	L	H
Decibels (1)	22	0			0			3	T		0			0			0			5	P		5	P		0		
		(0)		0	(0)		0	(1)		2T	(0)		2T	(0)		0	(0)		0	(1)		0	(1)		0	(0)		0
Logarithms (4)	23	0			0			0			0			3	P		0			5	P		5	R		0		
	24	0			0			0			0			3	P		0			5	P		5	R		0		
	25	0			0			0			0			2	P		0			5	P		5	R		0		
	26	0			0			0			0			1	P		0			5	P		5	R		0		
		(0)		0	(0)		0	(0)		0	(0)		0	(3)		0	(0)		0	(4)		0	(4)		.5R3T	(0)		0
Equations (6)	27	1	P		0			2	P		5	P		1	P		0			3	P		5	P		0		
	28	0			0			2	P		5	P		0			0			4	P		5	P		0		
	29	0			0			0			5	P		0			0			4	P		5	P		0		
	30	1	P		0			0			5	P		0			0			3	P		3	P		0		
	31	0			0			0			4	P		0			0			3	P		3	P		0		
	32	0			0			0			4	P		0			0			3	P		3	P		0		
		(0)		0	(0)		0	(2)		0	(6)		0	(0)		0	(0)		0	(6)		0	(6)		0	(0)		0
Algebraic Expressions (9)	33	0			0			0			5	P		0			0			3	P		5	P		0		
	34	0			0			0			5	P		0			0			3	P		5	P		0		
	35	0			0			0			5	P		0			0			3	P		5	P		0		
	36	0			0			0			5	P		0			0			3	P		0			0		
	37	0			0			0			5	P		0			0			3	P		0			0		
	38	0			0			0			5	P		0			0			3	P		0			0		
	39	0			0			0			5	P		0			0			3	P		0			0		
	40	0			0			0			5	P		0			0			3	P		0			0		
	41	0			0			0			5	P		0			0			3	P		0			0		
		(0)		0	(0)		0	(0)		0	(9)		0	(0)		0	(0)		0	(9)		0	(3)		0	(0)		0
Determinants (2)	42	0			0			0			0			0			0			0			0			0		
	43	0			0			0			0			0			0			0			0			0		
		(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0

1. Importance (I) ratings are based on responses made on a 6-point scale where 0=Not required, 1=Dispensable, 2=Somewhat useful, 4=Very important, and 5=Indispensable.
2. Skill acquisition level (L) ratings are based on a 3-point scale where P=Prerequisite, R=Reviewed, and T=Taught.
3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance).

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	DS AN/UYK-7 I	L	H	DS CP-642A/B I	L	H	DS Data Transmissions I	L	H	DS VYA-4/SYA-4 I	L	H	DS Periph. I	L	H	EW AN/ULQ6C I	L	H	EW AN/WLR11A(BAND 10) I	L	H	EW AN/WLR-1C I	L	H	EW AN/SLQ-26 I	L	H
Geometry & Trig-onometry (8)	44	0			0			1	P		0			2	P		0			0			3	P		0		
	45	0			0			3	R		0			2	P		0			0			3	P		0		
	46	0			0			2	P		0			4	R		0			0			3	P		0		
	47	0			0			3	R		0			2	P		0			0			3	P		0		
	48	0			0			0			0			1	P		0			0			3	P		0		
	49	0			0			0			0			0			0			0			3	P		0		
	50	0			0			0			0			4	T		0			0			3	P		0		
	51	0			0			0			4	R		2	P		0			0			3	P		0		
		(0)		0	(0)		0	(3)		2R	(1)		8R	(6)		3R4T	(0)		0	(0)		0	(8)		0	(0)		0
Phasors (7)	52	0			0			0			0			0			0			0			3	P		0		
	53	0			0			0			0			0			0			0			0			0		
	54	0			0			0			0			0			0			0			0			0		
	55	0			0			0			0			0			0			0			0			0		
	56	0			0			0			0			0			0			0			0			0		
	57	0			0			0			0			0			0			0			0			0		
	58	0			0			0			0			0			0			0			0			0		
		(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(1)		0	(0)		0
Number Bases (4)	59	4	R		5	P		5	P		5	P		4	P		0			0			5	P		0		
	60	2	R		5	P		5	P		5	P		2	P		0			0			5	P		0		
	61	2	R		5	P		0			5	P		0			0			0			5	P		0		
	62	3	R		5	P		5	P		5	P		0			0			0			5	P		0		
		(4)		1.5R	(4)		0	(3)		0	(4)		0	(2)			(0)		0	(0)		0	(4)		0	(0)		0
Boolean Algebra (8)	63	2	R		5	P		4	P		5	P		3	P		0			5	P		5	P		0		
	64	2	R		5	P		3	P		5	P		2	P		0			5	P		5	P		0		
	65	1	P		5	P		2	P		5	P		1	P		0			5	P		5	P		0		
	66	1	P		5	P		2	P		5	P		1	P		0			5	P		5	P		0		
	67	1	R		5	P		4	P		5	P		1	P		0			5	P		5	P		0		
	68	1	R		5	P		0			5	P		1	P		0			5	P		5	P		0		
	69	1	R		5	P		4	P		5	P		1	P		0			5	P		5	P		0		
	70	1	R		5	P		4	P		5	P		1	P		0			5	P		5	P		0		
		(2)		1R	(8)		0	(7)		0	(8)		0	(2)		0	(0)		0	(8)		0	(8)		0	(0)		0
TOTAL		11		3.75R	18		1R4T	30		2R2T	48		8R	16		3R4T	5		2R	48		0	54		5R3T	5		2R

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3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance).

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	ET I	ET L	ET H	FT AN/UYK-7 I	FT AN/UYK-7 L	FT AN/UYK-7 H	FT MK-47 I	FT MK-47 L	FT MK-47 H	FT MK-86 I	FT MK-86 L	FT MK-86 H	FT AN/SPG-53F I	FT AN/SPG-53F L	FT AN/SPG-53F H	ST MK-114 I	ST MK-114 L	ST MK-114 H	ST AN/SQS-53 I	ST AN/SQS-53 L	ST AN/SQS-53 H	ST MK-111 I	ST MK-111 L	ST MK-111 H	ST AN/SQS-26CX I	ST AN/SQS-26CX L	ST AN/SQS-26CX H
Arithmetic Operations with Numbers (4)	1	5	P		4	P		4	P		5	P		5	P		5	P		5	P		5	P		5	p	
	2	3	P		3	P		3	R		0			4	P		0			5	R		3	R		5	P	
	3	5	P		3	P		3	R		0			4	P		0			0			4	R		5	P	
	4	3	P		0			4	P		4	P		3	P		0			4	R		0			4	P	
		(4)		0	(3)		0	(4)		.5R	(2)		0	(4)		0	(1)		0	(3)			(3)		4R	(4)		0
Estimations (1)	5	3	P		1	P		2	T		0			3	R		0			4	T		0			0		
		(1)		0	(0)		0	(1)		.5T	(0)		0	(1)			(0)		0	(1)		12T	(0)		0	(0)		0
Fractions (5)	6	3	P		0			4	P		0			3	P		0			0			0			0		
	7	3	P		0			4	P		4	P		3	P		0			0			0			0		
	8	3	P		0			3	P		4	P		0			0			0			0			0		
	9	3	P		0			4	P		0			0			0			0			0			0		
	10	3	P		0			3	P		0			0			0			0			0			0		
		(5)		0	(0)		0	(5)		0	(2)		0	(2)		0	(0)		0	(0)		0	(0)		0	(0)		0
Units & Conversions (7)	11	5	P		3	P		5	P		4	P		5	P		4	P		5	R		5	R		4	P	
	12	5	P		2	P		5	P		5	R		5	P		0			5	R		0			4	P	
	13	5	P		2	P		5	P		4	R		4	P		3	P		5	R		4	R		0		
	14	0			0			3	P		0			4	P		0		0	0			0			0		
	15	0			0			4	R		0			0			0			0			0			0		
	16	3	P		0			4	P		5	R		5	P		4	P		5	R		3	R		5	R	
	17	5	P		0			5	P		0			5	P		3	P		5	R		0			3	R	
		(5)		0	(3)		0	(7)		1.5R	(4)		3R	(6)		0	(4)		0	(5)		100R	(3)		1R	(4)		5R
Scientific Notation (4)	18	5	P		4	R		3	R		0			3	P		0			2	R		4	R		4	R	
	19	5	P		1	P		3	R		0			4	P		0			0			4	R		0		
	20	5	P		1	P		3	R		0			3	P		0			0			3	R		0		
	21	0			1	P		3	R		0			0			0			0			0			0		
		(3)		0	(1)		1R	(4)		1R	(0)		0	(3)		0	(0)		0	(1)		8R	(3)		1R	(1)		2R

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2. Skill acquisition level (L) ratings are based on a 3-point scale where P=Prerequisite, R=Reviewed, and T=Taught.
3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance).

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	ET I	ET L	ET H	FT AN/UYK-7 I	FT AN/UYK-7 L	FT AN/UYK-7 H	FT MK-47 I	FT MK-47 L	FT MK-47 H	FT MK-86 I	FT MK-86 L	FT MK-86 H	FT AN/SPG-53F I	FT AN/SPG-53F L	FT AN/SPG-53F H	ST MK-114 I	ST MK-114 L	ST MK-114 H	ST AN/SQS-53 I	ST AN/SQS-53 L	ST AN/SQS-53 H	ST MK-111 I	ST MK-111 L	ST MK-111 H	ST AN/SQS-26CX I	ST AN/SQS-26CX L	ST AN/SQS-26CX H
Decibels (1)	22	5	P		0			2	T		5	T		5	P		0			4	R		0			0		
		(1)		0	(0)		0	(1)		.5T	(1)		4T	(1)		0	(0)		0	(1)		1R	(0)		0	(0)		0
Logarithms (4)	23	0			0			0			5	T		0			0			0			0			0		
	24	0			0			0			5	T		0			0			0			0			0		
	25	0			0			0			5	T		0			0			0			0			0		
	26	0			0			0			5	T		0			0			0			0			0		
		(0)		0	(0)		0	(0)		0	(4)		10T	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0
Equations (6)	27	0			0			4	P		4	R		5	P		5	R		4	R		0			5	P	
	28	0			0			4	P		4	P		4	P		4	R		4	R		0			0		
	29	0			0			3	R		0			2	P		0			5	T		0			0		
	30	0			0			3	R		0			0			0			0			0			0		
	31	0			0			0			0			0			0			0			0			0		
	32	0			0			0			0			0			0			0			0			0		
		(0)		0	(0)		0	(4)		2R	(2)		1R	(3)		0	(2)		12R	(3)		4R4T	(0)		0	(1)		0
Algebraic Expressions (9)	33	0			0			2	R		0			0			5	R		5	P		0			5	R	
	34	0			0			1	T		0			0			0			2	R		0			4	R	
	35	0			0			1	T		0			0			0			0			0			4	R	
	36	0			0			1	T		0			0			0			0			0			4	R	
	37	0			0			1	T		0			0			0			4	R		0			3	R	
	38	0			0			0			0			0			0			0			0			0		
	39	0			0			0			0			0			0			0			0			0		
	40	0			0			0			0			0			0			4			0			0		
	41	0			0			0			0			0			0			0			0			0		
		(0)		0	(0)		0	(1)		1R1T	(0)		0	(0)		0	(1)		4R	(4)		12R	(0)		0	(5)		20R
Determinants (2)	42	0			0			0			0			0			0			0			0			0		
	43	0			0			0			0			0			0			0			0			0		
		(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(0)		0

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2. Skill acquisition level (L) ratings are based on a 3-point scale where P=Prerequisite, R=Reviewed, and T=Taught.
3. Number in parentheses are the total number of skills within a topic area that affected performance (i.e., they were rated above "1" in importance).

Importance (I) and Skill Aquisition Level (L) Ratings and Hours (H) Spent Reviewing (R) or Teaching (T) Each Topic

Topic Area	Skill	ET I	ET L	ET H	FT AN/UYK-7 I	FT AN/UYK-7 L	FT AN/UYK-7 H	FT MK-47 I	FT MK-47 L	FT MK-47 H	FT MK-86 I	FT MK-86 L	FT MK-86 H	FT AN/SPG-53F I	FT AN/SPG-53F L	FT AN/SPG-53F H	ST MK-114 I	ST MK-114 L	ST MK-114 H	ST AN/SQS-53 I	ST AN/SQS-53 L	ST AN/SQS-53 H	ST MK-111 I	ST MK-111 L	ST MK-111 H	ST AN/SQS-26CX I	ST AN/SQS-26CX L	ST AN/SQS-26CX H
Geometry and Trig-onometry (8)	44	0			0			0			4	R		3	P		0			0			0			0		
	45	0			0			3	R		0			3	P		5	P		5	R		3	T		5	R	
	46	0			0			4	R		4	R		2	P		5	R		5	R		3	T		5	P	
	47	0			0			4	R		0			3	P		5	R		5	R		3	T		5	R	
	48	0			0			4	R		0			0			0			0			0			0		
	49	0			0			4	R		4	R		2	P		0			0			0			0		
	50	0			0			0			0			0			0			5	R		0			0		
	51	0			0			0			4	R		0			5	R		5	R		0			0		
		(0)		0	(0)		0	(5)		3R	(4)		4R	(5)		0	(4)		8R	(5)		45R	(3)		6T	(3)		5R
Phasors (7)	52	0			0			0			0			0			3	R		3	P		0			0		
	53	0			0			0			0			0			0			0			0			0		
	54	0			0			0			0			0			0			4	P		0			0		
	55	0			0			0			0			0			0			4	P		0			0		
	56	0			0			0			0			0			0			4	P		0			0		
	57	0			0			0			0			0			0			4	P		0			0		
	58	0			0			0			0			0			0			0			0			0		
		(0)		0	(0)		0	(0)		0	(0)		0	(0)		0	(1)		2R	(5)		0	(0)		0	(0)		0
Number Bases (4)	59	5	P		5	R		0			4	P		2	P		4	T		5	R		4	R		5	T	
	60	5	R		5	R		0			4	P		3	P		0			5	P		4	T		5	T	
	61	0			5	R		0			4	P		1	P		0			0			4	T		0		
	62	5	R		5	R		0			4	P		0			0			5	R		4	T		5	T	
		(3)		16R	(4)		4k	(0)		0	(4)		0	(2)		0	(1)		8T	(3)		20R	(4)		10R10T	(3)		5T
Boolean Algebra (8)	63	5	R		4	R		0			4	P		1	P		4	T		5	T		4	T		4	R	
	64	5	R		4	R		0			4	P		1	P		4	T		5	T		4	T		5	R	
	65	5	R		4	R		0			4	P		0			0			5	T		4	T		5	R	
	66	5	R		3	R		0			4	P		0			4	T		0			4	T		0		
	67	5	R		4	R		0			4	P		3	P		4	T		4	P		4	T		3	R	
	68	5	R		2	R		0			4	P		0			0			0			4	T		0		
	69	5	R		2	R		0			4	P		1	P		0			5	T		4	T		0		
	70	5	R		2	R		0			4	P		2	R		0			5	T		4	T		0		
		(8)		8R	(8)		16R	(0)		0	(9)		0	(2)		0	(4)		8T	(6)		50T	(8)		10R10T	(4)		40R
TOTAL		(30)		24R	19		21R	32		9R2T	31		8R14T	29		0	18		26R16T	37		190R6GT	24		2GR26T	25		7GR5T

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